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Elektrichestvo, No 11, 1949, pp 91,92.USSR CONFERENCE ON ANALOG SIMULATORSN. V. Korol'kov,
Cand Tech Sci

In July 1949, a conference on analog simulation of physical phenomena was held at ITMIVT (Institute of Precision Mechanics and Calculating Techniques), Academy of Sciences USSR.

Representatives of 45 organizations in Moscow, Leningrad, Kiev, Kuybyshev, Dnepropetrovsk, Penza, and other cities of the USSR took part in the conference.

Thirty-two papers were presented, mainly on the results of work in the field of theory and practical application of simulation of physical phenomena in various branches of science and engineering.

N. G. Bruyevich, Member of the Academy of Sciences USSR, made the introductory address at the opening of the conference. He emphasized the need for developing new simulators and improving well-known analytical mechanisms and machines. He said that these problems are being posed by essential requirements of modern science and engineering.

Bruyevich added that the scientists of the USSR have done a great deal to develop calculation techniques. More than 20 years ago, he said, Professor S. A. Gershgorin, who has done considerable research in the field of mathematical machines, suggested a special electrical resistance network to solve the Laplace equation. The speaker stated that research aimed at the development of new electrical mathematical machines and simulators has continued successfully from that time.

Bruyevich said that the first conference on analog simulators was called to discuss the results of research in this new field of science created by Soviet scientists.

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Professor L. I. Gutenmakher, Doctor of Technical Sciences, presented a lengthy paper on the present status and prospective development of simulation; he pointed out the rapid expansion of this new branch of engineering in the Soviet Union. Major points of his paper were as follows:

Mathematics generalizes the fundamental physical laws but is not very effective in solving equations. By now, engineering has so advanced that the necessary means for a revolution in the field of experimental mathematics (or machine mathematics) are available. Machine mathematics, in turn, makes possible the solution of equations. One may expect this stage to be followed by a brilliant new development of the natural sciences.

The theory and practice of simulation of all the basic equations in mathematical physics was developed 10 years ago in the Academy of Sciences USSR. Electrical dynamic simulators using electron tubes for solving systems of ordinary differential equations were first developed in the USSR.

The main problems at present are: (1) preparation of a staff of specialists for simulation of physical phenomena; (2) establishment of simulator laboratories and stations attached to large organizations; (3) the setting up of instruction courses to train personnel and the popularizing of this method among engineers and researchers; and (4) improvement and automatization of simulators and installations, mass production of elements and units, and reduction in the cost of simulation equipment.

The speaker also pointed out that, despite the fact that the Soviet Union was the first to invent and develop electrical and electron-tube simulators and integrators, American companies are stubbornly trying to claim credit for these important inventions. Academician G. M. Krzhizhanovskiy protested against this in an open letter in the periodical Proceedings Radio Engineers [Proc. I.R.E.] in November 1945.

Soviet papers on electron-tube simulators were published in the Soviet Union in early 1945 whereas in the US the first papers on the same subject were not published until May 1947. As far as their theoretical level is concerned, the papers by American authors are far inferior to those of Soviet authors.

In his report, L. G. Kogan, Candidate of Technical Sciences, ITMI VT, discussed the technical and economic effectiveness of solving differential equations (ordinary and partial) by electrointegrators or with the aid of the most modern digital machines (tabulators, punched-card machines, etc.). Kogan demonstrated by several examples that problems can be solved much more rapidly and cheaply by integrators than by digital machines.

The paper by I. S. Gradshteyn, Candidate of Physicomathematical Sciences, Moscow State University, was devoted to problems of accuracy in the operation of simulators. He told of research on the effect of small parameters on the solution of differential equations using simulators with amplifiers.

D. A. Efros, Candidate of Technical Sciences, All-Union Scientific Research Institute, Ministry of the Petroleum Industry USSR, spoke on the simulation of discontinuous currents of an incompressible liquid. Efros developed a new method for the study of cavitation so that the solution of this type of problem can be obtained by an electrointegrator.

Engineer A. D. Smirnov, NII (Scientific Research Institute [not further identified]), carried out experiments with the flow of liquid in radial settling tanks using type EI-11 and EI-12 electrointegrators.

N. I. Shteyn, Candidate of Technical Sciences, Moscow Power Engineering Institute, presented a paper on methods for simulation of wave guides. He demonstrated that wave guides could be investigated quite simply with the help of a simulator.

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S. F. Novakovskiy, Candidate of Technical Sciences, Dnepropetrovsk, used an electrointegrator to study the thermal processes in pressure pipelines built in frozen ground. The results of experiments are of great practical value since they show that the depth at which pipelines are laid can be reduced.

L. G. Kogan, Candidate of Technical Sciences, ITMIVT, reported on the simulation of a system for automatic voltage regulation. He used a special nonlinear converter he had developed from an idea suggested by Professor Gutenmakher.

N. P. Kunitskiy, Candidate of Technical Sciences, Electric Welding Section, Academy of Sciences USSR, presented a paper on simulation of an amplidyne rolling mill control system. Experiments conducted by the author with the aid of an electrointegrator clarified the effect of various parameters on the system.

N. V. Korol'kov, Candidate of Technical Sciences, ITMIVT, spoke on a method he worked out for the investigation of eddy currents set up by the motion of a conducting medium in a constant magnetic field.

Engineer A. A. Vishnevskiy, NII, presented a paper entitled "Selection of Parameters for Nonlinear Servomechanisms."

N. G. Gorchakov, Candidate of Technical Sciences, Electrical Engineering Institute, Academy of Sciences Ukrainian SSR, investigated the nonlinear twisting vibrations of a shaft with an elastic coupling with the aid of a simulator made from R, L, and C elements and semiconducting rectifiers.

N. Ya. Al'per, Candidate of Technical Sciences, Scientific Research Institute, Ministry of the Electrical Industry USSR, reported on the simulation of the field in the air gap of an induction machine under different conditions of magnetic potential distribution on the iron surface. As a result of the study, a number of important coefficients necessary for practical calculation of induction generators was obtained.

S. S. Vyalov, Candidate of Technical Sciences, Institute of Frost Studies, Academy of Sciences USSR, presented a paper on simulation of some thermal processes in the ground with the aid of electrointegrators. As a result of the investigation, conclusions were reached regarding efficient construction of foundations and thermal insulation.

S. N. Shan'gin, Doctor of Geologicomineralogical Sciences, All-Union Scientific Research Institute, Ministry of the Petroleum Industry USSR, told about application of simulation for geological analysis of petroleum deposits. Shan'gin stated that simulation permits one to determine the most effective distribution of wells in a petroleum deposit; it also helps in establishing the conditions necessary in maintaining pressure by means of water or gas injection into a layer, etc. Shan'gin pointed out the need for extensive application of the simulation method, stating that it should be adapted for use in petroleum deposit operations to enable engineers in the field to solve their everyday problems.

Engineers G. K. Kuzminok and I. V. Vipser, ITMIVT, reported on their use of electrointegrators to solve linear differential equations with constant coefficients. Kuzminok related his experience while building and running the prototype of the ELI-11 electrointegrator. This construction can be used by organizations which would like to build a simplified electrointegrator with their own resources.

Engineer I. V. Vipser presented in her report a comparative analysis of the ELI-10, ELI-11, and ELI-13 electrointegrators and also determined the operating errors of the ELI-13 by solving a number of test problems.

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Engineer I. A. Vissonova, ITMiVT, presented a paper on the methods of testing individual elements and units in electron-tube integrators of the ELI type.

Several reports dealt with the design and development of new integrators.

Professor V. Ye. D'yachenko, Corresponding Member, Academy of Sciences Ukrainian SSR, reported on research in the field of simulation at Kiev State University. He stated that in 1945 - 1947, Kiev State University, continuing Professor Gutenmakher's work, set up a simulation laboratory and constructed electrointegrators of the network type with fixed resistances for the purpose of solving potential problems (both plane and with axial symmetry) and also integrators with variable resistances. In 1948 - 1949, Kiev State University designed and is now completing a more modern electrointegrator of the network type with 1,200 junctions and an automatic measuring device.

Engineer Tantsyura presented an additional paper on the construction of electrointegrators at Kiev State University. He spoke of some interesting construction features which made it possible to increase flexibility and reliability in drawing up circuits for an electrointegrator.

The paper presented by Candidates of Technical Sciences V. P. Lebedev and B. A. Volynskiy was devoted to the work performed by the Institute of Automatics, All-Union Council of Scientific and Technical Societies, in the development of simulators. The institute constructed the new electrointegrator types EI-12, EM-1, EM-2, GPN-1, EI-21, and EM-4 "lambda," all intended for the solution of special problems.

Engineer E. M. Borisov, Institute of Automatics, All-Union Council of Scientific and Technical Societies, presented a paper on the construction and operation of type EI-22 electrointegrators.

Professor B. M. Mordovin gave a report on work in the development of simulators by the Ministry of Machine and Instrument Building.

Engineer N. S. Nikolayev spoke on behalf of the "SAM" plant in Penza. He threw some light on the difficulties encountered in building an electron-tube integrator and the progress achieved by the plant.

Engineer N. P. Belyakov, ITMiVT, in his paper entitled "Experience and Trends in the Design of Electrointegrators," surveyed the existing types of electrointegrators and the peculiarities of their construction.

L. A. Lyusternik, Corresponding Member, Academy of Sciences USSR, reported on an interesting application of simulators. He worked out a method of determining eigenvalues and eigenfunctions with the aid of simulators made up of resistors and capacitors. The determination of eigenvalues and eigenfunctions is very important in many problems of physics and engineering (quantum physics, theory of oscillations, strength of materials, etc.).

Engineer K. K. Reydik, Institute of Automatics, All-Union Council of Scientific and Technical Societies, also reported on the construction of an instrument for determining eigenvalues and eigenfunctions.

Engineer A. G. Gesse, Institute of Automatics, All-Union Council of Scientific and Technical Societies, presented a paper dealing with the institute's work in the development of three-dimensional models of electrointegrators. He made a detailed analysis of peculiarities inherent to the three-dimensional models and, from this analysis, reached important conclusions regarding possible designs of three-dimensional models.

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Engineer M. M. Dubinin, Scientific Research Institute, Ministry of the Petroleum Industry USSR, reported on his experience with the use of an "electrical magnifier" for the solution of problems in subterranean hydraulics.

P. F. Fil'chakov, Candidate of Technical Sciences, Kiev Institute of Mathematics, Academy of Sciences Ukrainian SSR, told of a simulator which he designed to solve problems described by the Laplace equation.

As a result of deliberations at the conference on analog simulators, a resolution was passed emphasizing the fact that simulation methods, which make it possible to solve quickly and effectively the most intricate problems in various fields of science and engineering, are becoming a powerful tool in the hands of Soviet scientists and engineers. The Soviet Union, where both the theory and application of simulation originated, is far ahead of the US and England in this field.

The conference demonstrated that a number of organizations have developed original electrointegrators and simulators; these have already been used to solve important practical problems. The inadequacy of the efforts to popularize this powerful method and to introduce it into scientific, educational, and planning organizations, and the insufficient number of qualified specialists in simulation were noted. A resolution was adopted calling for publication of scientific texts and popular literature on the theory and practice of simulation as well as for periodical union-wide conferences on machine mathematics.

It was decided to ask the Ministry of Higher Education USSR to set up special courses and laboratory experiments in the theory and application of simulation in both higher educational and higher technical educational institutions.

To satisfy the growing demand for electrointegrators and simulators, the Ministry of Machine and Instrument Building USSR must start planning the production of a series of universal electrointegrators and also typical components and units so that other organizations can assemble simulators. The communications-equipment industry is faced with the task of manufacturing accurate and reliable parts and elements needed in the modern integrators.

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